

~~SECRET~~BALLOON, PORTABLE HYDROGEN  
GENERATOR 25X1

April 17, 1958

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Dear Sir:

This letter report describes the activity under Task Order No. C during March, 1958.

During this period, two 1/5-scale runs were made, and some of the experimental data were analyzed to determine (1) the effect of increasing the  $\text{CoCl}_2$  concentration on total generation time, and (2) the effect of altitude on the amount of water-vapor condensation and lift. Also, modifications of the small-generator design and operating procedure were made and evaluated.

#### Small-Generator Runs

The previous runs in the small experimental generator have indicated that the quantitative relationship among catalyst concentration, initial temperature, and time for total generation, as deduced from the small-scale laboratory studies of this system, needs to be revised. The selection of catalyst-concentration values on the basis of the above-mentioned quantitative relationship and the use of the corresponding amounts of  $\text{CoCl}_2$  in experiments in the 1/5-scale generator have led to total generation times in excess of the specified maximum, 60 minutes. In this connection, calculations were made to investigate the effect of increasing the  $\text{CoCl}_2$  concentration by a factor of 2. On the basis of the assumption that

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adiabatic conditions prevail during the reaction, the calculations showed that doubling the  $\text{CoCl}_2$  concentration reduces the total generation time by about 38 per cent.

Two 1/5-scale runs were made (Runs 9 and 10). In both, the amounts of  $\text{CoCl}_2$  used were in excess of those indicated by the previously arrived-at relationship. The  $\text{CoCl}_2$  was added as one gallon of solution, via the 20-hole ring. The results are summarized in Table 1; the data for Run 3 are included to provide a basis for comparison for Run 10.

It is of interest to note that the total generation time for Run 10 was about 31 per cent less than that for Run 3. This result shows good agreement between the experimental and the calculated effect of doubling the  $\text{CoCl}_2$  concentration.

Data on the volumes of hydrogen and water vapor were not obtained for Run 10. The generation reaction in this run was followed by recording the bath temperature rather than by measuring the amount of generated gas by means of a flow meter. Theoretically, the amount of hydrogen generated in this reaction from the beginning to any particular time is directly proportional to the corresponding fraction of the total temperature rise, i.e., to the fraction represented by the temperature rise incurred during the time period of interest divided by the total temperature rise occurring from the beginning till the completion of the reaction. Some of the experimental data obtained from previous runs corroborated this theoretical relationship.

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TABLE 1. DATA FOR ADDITIONAL RUNS IN 1/5-SCALE GENERATOR

	Run No.		
	9	10	3
Hydrogen, cu ft (corr)	686	-	686
Water vapor, cu ft (corr)	15.2	-	31
Initial temperature, F	66	63	62
Total temperature rise, F	46	57	63
CoCl <sub>2</sub> ·6H <sub>2</sub> O, lbs	<sup>+21%</sup> 1.67	<sup>+14%</sup> 2.66	1.37
Excess* amount of catalyst, per cent	60 <sub>-25%</sub>	120 <sub>-31%</sub>	9
Total generation time, min	64	59	85
Completion of reaction, per cent	97.9	-	95.5

\*Amount of catalyst in excess of that indicated by the previously deduced relationship among catalyst concentration, initial temperature, and total generation time.

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Condensation and on Lift

Calculations were made of the amount of water vapor condensed from a  $H_2-H_2O$  mixture as the ambient temperature decreases (i.e., as the balloon rises). The calculations were based on (1) the data obtained from Run 5, where 51 cu ft of water vapor were generated along with the hydrogen; (2) an average temperature of the gas at sea level of 77 F; and (3) an assumed temperature drop of 5.4 F per 1,000 feet of altitude. The results of the calculations are as follows:

<u>Altitude, ft</u>	<u>Amount of Water Vapor Condensed, per cent</u>
0	61
1,660	65
3,300	70
9,900	98

These data indicate that, at an altitude of about 10,000 feet, practically all of the water vapor will be condensed.

To obtain an approximation of the effect of the water-vapor condensation on lift, calculations were made for the following conditions:

Amount of $H_2$	3,500 cu ft
Amount of water vapor	8.5 lb
Ambient temperature	70 F
Average gas temperature	91 F

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The calculated values for lift under these conditions are 281 lb at sea level and 257 lb at an altitude of 9,900 feet.

Additional calculations will be made for a variety of conditions. The variables that will be considered are water-vapor content, ambient temperature, average gas temperature, and altitude.

#### The Generator Units

The 1/5-scale generator was modified to incorporate some of the design changes that are contemplated for the full-scale experimental unit. The 30-inch-long water-inlet zipper was patched and sealed, and a 4-inch-diameter neoprene-coated-fabric water-inlet tube was fabricated and attached to the small generator. A 2-inch-diameter catalyst-entry tube was fabricated and assembled to the catalyst-feed tube. A neoprene-coated-fabric bag was attached to the end of the catalyst-entry tube. This bag was large enough so that it could be pulled over a 5-gallon bucket and the bucket upended so as to simulate the currently contemplated procedure of pouring catalyst into the full-scale generator. This entry-tube assembly and the feed tube were then used for adding the 1 gallon of catalyst solution used in Runs 9 and 10.

A polyethylene container was fabricated and filled with 20 pounds of sodium borohydride for test pouring through a 5-inch-diameter opening in the 1/5-scale generator. This container was easy to handle and was emptied in approximately 1 minute.

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The 1/5-scale generator, modified as indicated above, was placed in water, 2 feet deep, and simulated field tests were made in regard to the handling of the generator in water, the entry of the water through the entry tube, the tie-off of the entry tube, and the pouring of 5 gallons of water through the catalyst-entry tube. Based on the experience gained from these tests, the water-inlet tube and the catalyst-entry tube, as described above, were incorporated in the design of the full-scale unit. However, two water-inlet tubes were specified for the full-scale generator, in order to reduce the time required to fill the unit to the proper level.

The total appropriation on this Task Order was \$39,375. As of April 1, 1958, the unexpended balance was approximately \$7,100.

Sincerely,

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